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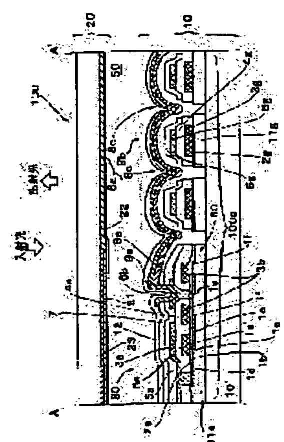
(54) ELECTRO-OPTICAL DEVICE AND ELECTRONIC EQUIPMENT

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an electro-optical device in which a light reflection film having a light diffusion function can be formed in a suitable state while suppressing the increase of the manufacturing cost to the minimum, and to provide an electronic equipment provided with it.

SOLUTION: In the array substrate 10 of an active matrix electro-optical device 100 of the reflection type or the semi-transflective type, there are formed on the surface of a light reflection film 8a, a ground protective film 11a, a gate insulator 2a, scanning lines 3a, a first interlayer insulation film 4a, data lines 6a and a recessed-projected pattern 8g formed of the steps or concavity and convexity of a thin film for recessed-projected formation 11g which is formed by leaving part of a thin film of the same layer as a second interlayer insulating film 5a by the predetermined pattern, and thin layers 2g, 3g, 4g, 6g, and 5g. Consequently, the light made incident from the counter substrate 20 is diffused and reflected towards the counter substrate 20.



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CLAIMS

[Claim(s)]

[Claim 1] In the electro-optic device equipped with the active component for pixel switching which connects with one or more wiring electrically at least for every pixel, and the light reflex film on the substrate which pinches electrooptic material In the field which laps with the light reflex film and a flat-surface target concerned in by the side of the lower layer of said light reflex film The thin film for concavo-convex formation in which the thin film of at least one layer in the insulator layer formed between the layers of said one or more wiring and those wiring or in the upper layer or a lower layer and this layer was alternatively formed by the predetermined pattern, The electro-optic device characterized by preparing the agenesis field of the thin film for concavo-convex formation concerned, and forming the concavo-convex pattern in the front face of said light reflex film of the formation field and agenesis field of said thin film for concavo-convex formation.

[Claim 2] The electro-optic device characterized by forming the flattening film in the lower layer [of said light reflex film], and upper layer side of said thin film for concavo-convex formation in claim 1.

[Claim 3] It is the electro-optic device characterized by the average thickness of said flattening film being the range from [of the difference of elevation of said concavo-convex pattern] 1/2 to twice in claim 2.

[Claim 4] The electro-optic device characterized by containing the electric conduction film of one and this layer in said thin film for concavo-convex formation among said wiring at least in claim 1 thru/or either of 3.

[Claim 5] Said thin film for concavo-convex formation which consists of electric conduction film of 1 of said wiring and this layer in claim 4 is an electro-optic device characterized by dissociating electrically with said wiring.

[Claim 6] It is the electro-optic device which said active component is a thin film transistor or a thin-film diode component, and is characterized by one of said wiring being the scanning line in claim 1 thru/or either of 5.

[Claim 7] It is the electro-optic device which said active component is a thin film transistor, and is characterized by one of said wiring being the data line in claim 1 thru/or either of 5.

[Claim 8] It is the electro-optic device characterized by for said active component being a thin film transistor, and said wiring containing both the electric conduction film that consists of the layer as each of the scanning line and the data line with said same thin film for concavo-convex formation including both the scanning line and the data line in claim 1 thru/or either of 5.

[Claim 9] It is the electro-optic device characterized by the thickness of said electric conduction film having 500nm or more in claim 4 thru/or either of 8, respectively.

[Claim 10] It is the electro-optic device characterized by the part in which said electric conduction film is equivalent to one half of thickness dimensions at least in claim 4 thru/or either of 9 consisting of the aluminum film, the tantalum film, molybdenum film, or alloy film that uses either of these metals as a principal component.

[Claim 11] It is the electro-optic device characterized by processing said electric conduction film by the dry etching method in claim 4 thru/or either of 10.

[Claim 12] The electro-optic device characterized by containing the insulator layer in said thin film for concavo-convex formation at least in claim 1 thru/or either of 11.
[Claim 13] The electro-optic device characterized by containing the insulating layer which becomes said insulator layer from the same layer as the substrate protective coat currently formed in the lower layer from an active component and wiring in claim 12.
[Claim 14] The electro-optic device which said wiring is plurality and is characterized by containing the insulating layer which consists of the same layer as the interlayer insulation film with which between wiring of these plurality is insulated electrically in claims 12 or 13 at said insulator layer.
[Claim 15] The electro-optic device characterized by containing the insulating layer which becomes said insulator layer from the same layer as the protection insulator layer currently formed in the upper layer of said wiring in claim 12 thru/or either of 14.
[Claim 16] It is the electro-optic device characterized by the part in which said insulator layer is equivalent to one half of thickness dimensions at least in claim 12 thru/or either of 15 consisting of silicon oxide.
[Claim 17] It is the electro-optic device characterized by coming to form said insulator layer by the dry etching method in claim 16.
[Claim 18] It is the electro-optic device which said active component is a thin film transistor in claim 14 thru/or either of 17, and is characterized by the semi-conductor film of the active layer of said thin film transistor and this layer having lapped with the lower layer of said thin film for concavo-convex formation superficially.
[Claim 19] It is the electro-optic device characterized by not having the field where the heights which said concavo-convex pattern adjoins in claim 1 thru/or either of 18 are repeated with the flat-surface distance of 20 micrometers or less.
[Claim 20] It is the electro-optic device characterized by the difference of elevation of said concavo-convex pattern being 500nm or more in claim 1 thru/or either of 19.
[Claim 21] It is the electro-optic device characterized by the difference of elevation of said concavo-convex pattern being 800nm or more in claim 20.
[Claim 22] It is the electro-optic device characterized by being formed with the flat-surface configuration in which, as for said thin film for concavo-convex formation, a periphery edge does not have an acute angle in claim 1 thru/or either of 21.
[Claim 23] It is the electro-optic device characterized by coming to be formed using the mask drawn as a polygon which consists of the die length of 2 double less or equal of the resolution of the photolithography equipment with which said thin film for concavo-convex formation is used in claim 22.
[Claim 24] For the flat-surface dimension for a flat part of 3 or less times, the tilt angle to a substrate is [each the heights and the crevice which constitute said concavo-convex pattern in claim 1 thru/or either of 23] the electro-optic device with which it is characterized by being 10 micrometers or less.
[Claim 25] It is the electro-optic device characterized by the flat-surface distance between the heights which said concavo-convex pattern adjoins in claim 1 thru/or either of 24 being the range from 5 times of the difference of elevation of said concavo-convex pattern to 20 times.
[Claim 26] The electro-optic device with which dispersion in the tilt angle of a side face is characterized by being 10 or less degrees in a field in claim 1 thru/or either of 25 between each heights which constitute said concavo-convex pattern.
[Claim 27] The electro-optic device with which dispersion in the tilt angle of a side face is characterized by being 5 or less times in a field in claim 26 between each heights which constitute said concavo-convex pattern.
[Claim 28] Each heights which constitute said concavo-convex pattern in claim 1 thru/or either of 27 are electro-optic devices characterized by the inclination of a side face being unsymmetrical to the core of the heights concerned.
[Claim 29] Each heights which constitute said concavo-convex pattern in claim 28 are electro-optic

devices characterized by the one where the inclination of a side face is steeper having turned to the direction of clear vision.
[Claim 30] It is the electro-optic device characterized by being the unsymmetrical pattern the core of a lap and whose core of each pattern said thin film for concavo-convex formation consisted of two or more electric conduction film at least, and the convex pattern with which the electric conduction film of these plurality was left behind has lapped mutually superficially at least partially in claims 28 or 29, and do not correspond.
[Claim 31] It is the electro-optic device characterized by being the unsymmetrical pattern the core of a lap and whose core of each pattern said thin film for concavo-convex formation consisted of two or more insulator layers at least, and the concave pattern by which opening was carried out to the insulator layer of these plurality has lapped superficially at least partially in claim 28 thru/or either of 30, and do not correspond.
[Claim 32] It is the electro-optic device characterized by distributing superficially asymmetrically the core of the concave pattern by which opening was carried out to the convex pattern with which said thin film for concavo-convex formation consisted of at least one insulator layer and at least one electric conduction film in claim 28 thru/or either of 31, and said electric conduction film was left behind, and said insulator layer.
[Claim 33] It is the electro-optic device characterized by having the forward tapered shape configuration which comes to form the opening pattern by the side of the lower layer of the crevice where it always comes to form outside the remnants pattern by the side of the lower layer of the heights from which said thin film for concavo-convex formation constitutes said concavo-convex pattern in claim 1 thru/or either of 32, and it constitutes said concavo-convex pattern from a remnants pattern by the side of the upper layer inside the opening pattern by the side of the upper layer.
[Claim 34] The convex pattern with which said thin film for concavo-convex formation consisted of two or more electric conduction film at least, and the electric conduction film was left behind more in the upper layer in claim 33 is an electro-optic device characterized by always being formed in the inside field of the formation field of the convex pattern with which the electric conduction film was left behind in the lower layer.
[Claim 35] The concave pattern by which said thin film for concavo-convex formation consisted of two or more insulator layers at least, and opening was carried out more to the insulator layer in the lower layer in claims 33 or 34 is an electro-optic device characterized by always being formed in the inside field of the formation field of the convex pattern formed in the upper insulator layer.
[Claim 36] The concave pattern by which opening was carried out to the convex pattern with which said thin film for concavo-convex formation consisted of at least one insulator layer and at least one electric conduction film, and said electric conduction film was left behind in claim 1 thru/or 35, and said insulator layer is an electro-optic device characterized by not having the part which overlap mutually superficially.
[Claim 37] Each insulator layer or the electric conduction film is an electro-optic device with which it is characterized by for said thin film for concavo-convex formation consisting of two or more insulator layers or electric conduction film in claim 1 thru/or 36, and thickness being 800nm or less.
[Claim 38] It is the electro-optic device characterized by said electrooptic material being liquid crystal in claim 1 thru/or either of 37.
[Claim 39] Electronic equipment characterized by using as a display the electro-optic device specified to claim 1 thru/or either of 38.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to an electro-optic device and the electronic equipment which used it. It is related with the configuration of the pixel in the electro-optic device concerned in more detail.

[0002]

[Description of the Prior Art] Electro-optic devices, such as liquid crystal equipment, are used as a display of the direct viewing type of various devices. With the liquid crystal equipment of the active-matrix mold using TFT as a nonlinear device for pixel switching, among such electro-optic devices As shown in drawing 21 , in the direction of the TFT array substrate 10, among the TFT array substrate 10 which pinches the liquid crystal 50 as electrooptic material, and the opposite substrate 20 TFT30 for pixel switching (a thin film transistor / Thin Film Transistor) and pixel electrode 9a which consists of transparent conductive film, such as ITO film electrically connected to data-line 6a through this TFT30, are formed.

[0003] By the thing of a reflective mold, or a transflective and a half reflective mold, among liquid crystal equipment Light reflex film 8a for turning to the direction of the opposite substrate 20 the outdoor daylight which has carried out incidence, and reflecting from the opposite substrate 20 side, is formed in the lower layer side of pixel electrode 9a. The method which displays an image by the light by which reflected the light which carried out incidence from the opposite substrate 20 side by the TFT array substrate 10 side, and outgoing radiation was carried out from the opposite substrate 10 side is in use. In addition, although it is also possible to display an image by the light by which reflected the outdoor daylight which carried out incidence from the TFT array substrate 10 side by forming the light reflex film in the opposite substrate 20 side by the opposite substrate 20 side, and outgoing radiation was carried out from the TFT array substrate 10 side Since light does not penetrate in the formation field of TFT30 in order that light may penetrate the TFT array substrate 10 in such a configuration, it is disadvantageous at the point of performing a bright display. Moreover, although the structure of forming a reflecting plate in a liquid crystal [of the array substrate 10 and the opposite substrate 20] 50 and reverse side is also considered, generally display quality falls from the problem of brightness and parallax considerably compared with the above inside electrode structures.

[0004] In the liquid crystal equipment of such a reflective mold, or a transflective and a half reflective mold, if the directivity of light reflected by light reflex film 8a is strong, an angle-of-visibility dependency, like brightness differs at the include angle which sees an image will come out notably. In case liquid crystal equipment is manufactured conventionally, then, on the front face of 2nd interlayer insulation film 5a (surface protective coat) After applying a photopolymer called acrylic resin etc. to the thickness of 800nm - 1500nm, by carrying out patterning of this photopolymer using a photolithography technique Concavo-convex pattern 8g is formed in the front face of light reflex film 8a formed in the field which laps with light reflex film 8a superficially in by the side of the lower layer of light reflex film 8a at the upper layer side by leaving alternatively the photopolymer layer 13 for concavo-convex formation by the predetermined pattern.

[0005] For this reason, the light which carried out incidence from the opposite substrate 20 is the front face of light reflex film 8a, and since it reflects being spread and it faces to the opposite substrate 20, it can suppress the angle-of-visibility dependency of the image displayed with liquid crystal equipment.
[0006] In addition, although TFT was shown as an example as an active component for pixel switching, it does not matter at all even if it uses thin-film diode components (a TFD component / Thin FilmDiode component), such as an MIM (Metal InsulatorMetal) component, as an active component here.
[0007]
[Problem(s) to be Solved by the Invention] However, like conventional liquid crystal equipment, by the approach of forming concavo-convex pattern 8g in the front face of light reflex film 8a by the photopolymer layer 13 for concavo-convex formation, in order to have to add the process which applies a photopolymer, there is a trouble that a manufacturing cost increases. Moreover, since it is necessary to also add the process for leaving this applied photopolymer alternatively as a photopolymer layer 13 for concavo-convex formation using a photolithography technique, there is a trouble that a manufacturing cost increases.
[0008] While the technical problem of this invention suppresses increase of a manufacturing cost in view of the above trouble to the minimum, it is in offering the electro-optic device which can form the light reflex film equipped with the optical diffusion function in a suitable condition, and electronic equipment equipped with it.
[0009]
[Means for Solving the Problem] In order to solve the above-mentioned technical problem, in this invention, on the substrate which pinches electrooptic material In the electro-optic device equipped with the active component for pixel switching which connects with one or more wiring electrically at least for every pixel, and the light reflex film In the field which laps with the light reflex film and a flat-surface target concerned in by the side of the lower layer of said light reflex film The thin film for concavo-convex formation in which the thin film of at least one layer in the insulator layer formed between the layers of said one or more wiring and those wiring or in the upper layer or a lower layer and this layer was alternatively formed by the predetermined pattern, The agenesis field of the thin film for concavo-convex formation concerned is prepared, and it is characterized by forming the concavo-convex pattern in the front face of said light reflex film of the formation field and agenesis field of said thin film for concavo-convex formation.
[0010] In this invention, in the field which laps with the light reflex film and a flat-surface target in by the side of the lower layer of the light reflex film It is alternatively formed by the predetermined pattern, using as the thin film for concavo-convex formation the thin film of at least one layer in the insulator layer formed between the layers of said one or more wiring and those wiring, or in the upper layer or a lower layer, and this layer. A concavo-convex pattern is formed in the front face of the light reflex film using the level difference and irregularity resulting from the existence of this thin film formation for concavo-convex formation. Here, the insulator layer formed between the layers of said one or more wiring and those wiring or in the upper layer or a lower layer is not concerned with whether irregularity is given to the light reflex film, but it is formed, and after they form a predetermined thin film in the whole front face of a substrate, they are surely formed by carrying out patterning using a photolithography technique etc. For this reason, the process which forms the insulator layer formed between the layers of said one or more wiring and those wiring or in the upper layer or a lower layer can be used as it is, and the thin film for concavo-convex formation of they and this layer can be alternatively formed by the predetermined pattern. Therefore, the light reflex film to which a membrane formation process is added and which was equipped with the optical diffusion function, without adding can be formed. Moreover, since it is also easy to avoid the field which forms an active component and to form the thin film for concavo-convex formation on a substrate, there is no trouble in performing micro processing for forming an active component.
[0011] In addition, an active component here may be a non-linearity 2 terminal component called a TFD

component equipped with MIM structure etc., and may be TFT. moreover -- ** it will not matter even if it uses the polish recon Si for an active layer even if it uses an amorphous silicon for an active layer if it is TFT -- a reverse stagger mold, an order stagger mold, and a KOPURENA mold -- even if it is which structure, it does not interfere.

[0012] In this invention, it is more desirable than said thin film for concavo-convex formation that the flattening film is formed in an upper layer side the lower layer side of said light reflex film. Thus, if constituted, since the level difference resulting from the existence of the thin film for concavo-convex formation and irregularity will become a gently-sloping configuration without an edge and will be reflected in the front face of the light reflex film as a concavo-convex pattern with the flattening film, generating of the angle-of-visibility dependency resulting from an edge can be prevented.

[0013] Here, as for the average thickness of said flattening film, it is desirable that it is the range from [of the difference of elevation in said concavo-convex pattern] 1/2 to twice. If the average thickness of said flattening film exceeds the twice of the difference of elevation of a concavo-convex pattern, the angle-of-visibility dependency of an image will become strong instead of irregularity being eliminated, a specular reflection component being too strong and a bright image being obtained with the flattening film. On the other hand, thickness of said flattening film will not be able to eliminate an edge certainly with the flattening film by under double [of the difference of elevation of a concavo-convex pattern / 1 / 2 double], but the angle-of-visibility dependency resulting from an edge will occur. So, the brightness of an image is also securable while being able to suppress an angle-of-visibility dependency, if the thickness of said flattening film is set as the range from [of the difference of elevation in said concavo-convex pattern] 1/2 to twice.

[0014] In this invention, although the number of said thin films for concavo-convex formation may be one, being formed is desirable more than two-layer. Although it is necessary to form the thin film for concavo-convex formation with thickness equivalent to the wavelength of a light field in order to form the concavo-convex pattern which has sufficient difference of elevation for the front face of the light reflex film, so thick a thin film is not usually formed in TFT. However, if said thin film for concavo-convex formation is formed more than two-layer, even when a thin film is thin, the concavo-convex pattern which has sufficient difference of elevation for the front face of the light reflex film can be formed.

[0015] In this invention, the configuration in which the electric conduction film of one and this layer is contained among said wiring is employable as said thin film for concavo-convex formation at least, for example. In this case, as for said thin film for concavo-convex formation which consists of electric conduction film of 1 of said wiring, and this layer, dissociating electrically with said wiring is desirable.

[0016] In this invention, said active component is TFT or a TFD component, and one of said wiring is the scanning line in this case.

[0017] In this invention, when said active component is TFT, the scanning line or a gate electrode, and the electric conduction film of this layer are contained in said thin film for concavo-convex formation at least. Such the scanning line and a gate electrode are formed by carrying out patterning using a photolithography technique, after forming the electric conduction film on the surface of [whole] a substrate. For this reason, since the process which forms the scanning line or a gate electrode can be used as it is and the scanning line or a gate electrode, and the thin film for concavo-convex formation of this layer can be alternatively formed by the predetermined pattern, it is not necessary to add a new process to forming a concavo-convex pattern in the front face of the light reflex film.

[0018] In this case, it is desirable to separate electrically said thin film for concavo-convex formation which consists of said scanning line or said gate electrode, and electric conduction film of this layer with said scanning line and said gate electrode, and for the scanning line to be in other components and short circuit conditions through the thin film for concavo-convex formation, or to prevent to cause capacity coupling.

[0019] In this invention, when said active component is TFT, the configuration in which the data line or a

source electrode; and the electric conduction film of this layer are contained can be adopted as said thin film for concavo-convex formation at least. After such the data line and a source electrode also form the electric conduction film on the surface of [whole] a substrate, they are formed by carrying out patterning using a photolithography technique. [as well as the scanning line or a gate electrode] For this reason, since the process which forms a source electrode can be used as it is and the data line or a source electrode, and the thin film for concavo-convex formation of this layer can be alternatively formed by the predetermined pattern, it is not necessary to add a new process to forming a concavo-convex pattern in the front face of the light reflex film.
[0020] Said thin film for concavo-convex formation which consists of said data line and said source electrode, and electric conduction film of this layer in this case is electrically separated with said data line and said source electrode, and it is desirable to prevent that the data line and a source electrode will be in other components and short circuit conditions through the thin film for concavo-convex formation.
[0021] When adopting such a configuration, as for the thickness of said electric conduction film, it is desirable that it is 500nm or more, respectively.
[0022] As for said electric conduction film, in this invention, it is desirable that the part which is equivalent to one half of thickness dimensions at least consists of the aluminum film, the tantalum film, molybdenum film, or alloy film that uses either of these metals as a principal component. Moreover, as for these electric conduction film, being processed by dry etching is desirable. With [when forming said concavo-convex formation thin film from the electric conduction film / although this electric conduction film will be formed thick] such a metallic material, while a membrane formation rate is quick and controls a taper configuration by dry etching easily to the top where membranous stress is comparatively low, there is an advantage that patterning can be carried out.
[0023] In this invention, the configuration in which the insulator layer is contained may be adopted as said thin film for concavo-convex formation at least.
[0024] What is necessary is just to adopt as said thin film for concavo-convex formation at least the configuration in which the interlayer insulation film for the insulation between the gate sources as said insulator layer is contained in this invention, for example, when said active component is a thin film transistor. After such an interlayer insulation film forms an insulator layer on the surface of [whole] a substrate, patterning is carried out using a photolithography technique and a contact hole is formed. For this reason, since the process which forms an interlayer insulation film and a contact hole can be used as it is and an interlayer insulation film and the thin film for concavo-convex formation of this layer can be alternatively formed by the predetermined pattern, it is not necessary to add a new process to forming a concavo-convex pattern in the front face of the light reflex film.
[0025] In this invention, you may be the configuration that the substrate protective coat formed in the lower layer side of said active component as said insulator layer is contained in said thin film for concavo-convex formation, for example. Since this substrate protective coat is what is formed in order to protect an active component and wiring, even when forming the thin film for concavo-convex formation, it does not need to add a membrane formation process. Moreover, since gate dielectric film and an interlayer insulation film are formed in the upper layer side of a substrate protective coat, in case a contact hole is formed in these gate dielectric film and interlayer insulation films, it is possible to use the process as it is and to carry out patterning of the substrate protective coat. So, since it is also possible to use other processes and to form alternatively a substrate protective coat and the thin film for concavo-convex formation of this layer by the predetermined pattern, it is necessary to add no new process to forming a concavo-convex pattern in the front face of the light reflex film.
[0026] In this invention, you may be the configuration that the protection insulator layer formed in the said active component and upper layer side of wiring as said insulator layer is contained in said thin film for concavo-convex formation, for example. Since this protection insulator layer is that in which patterning is carried out using a photolithography technique, and a contact hole is formed after forming

it in order to protect an active component and wiring, even when forming the thin film for concavo-convex formation, it does not need to add a membrane formation process and a patterning process.
[0027] As for said insulator layer, in this invention, it is desirable that the part which is equivalent to one half of thickness dimensions at least consists of silicon oxide. If it is silicon oxide although this insulator layer will be formed thick when forming said concavo-convex formation thin film from an insulator layer, there is an advantage that a membrane formation rate is quick and patterning of it can be carried out by dry etching at a good configuration to the top where membranous stress is comparatively low.
[0028] In this invention, said active component is TFT, and when using an interlayer insulation film and the thin film of this layer as a thin film for concavo-convex formation, it is desirable that the semi-conductor film of said active layer of TFT and this layer has lapped superficially to the crevice which constitutes said concavo-convex pattern at least. Although the film or substrate ingredient of a substrate of this field also has a possibility that it may be exposed to an etching reagent or etching gas in case etching removal of an interlayer insulation film and the thin film of this layer is carried out to the field which is equivalent to a concavo-convex pattern in a crevice If it leaves the semi-conductor film of said active layer of TFT and this layer to the field equivalent to a crevice, since this semi-conductor film will function as an etching stopper, it can prevent that etching removal of the lower layer is carried out, and effectiveness is in prevention of contamination and control of the configuration of a crevice.
[0029] As for said concavo-convex pattern, in this invention, it is desirable not to have the field where adjoining heights are repeated with the flat-surface distance of 20 micrometers or less. In a concavo-convex pattern, if the field where adjoining heights are repeated with the flat-surface distance of 20 micrometers or less exists, the interference color will occur in relation with the wavelength of light, but if there is such no repeat field, generating of the interference color can be prevented.
[0030] In this invention, as for the difference of elevation of said concavo-convex pattern, it is desirable that it is 500nm or more, and, as for especially the difference of elevation of said concavo-convex pattern, it is desirable that it is 800nm or more. If the difference of elevation of a concavo-convex pattern is too small, in a dispersion property, in a visible region, frequency dependent will occur, an image will color, but if the difference of elevation of said concavo-convex pattern is 500nm or more, such coloring is mitigable, and especially, if the difference of elevation of said concavo-convex pattern is 800nm or more, such coloring can be prevented certainly.
[0031] As for said thin film for concavo-convex formation, in this invention, it is desirable that the periphery edge is formed with the flat-surface configuration which does not have an acute angle. At the time of the design of an exposure mask, such a configuration is realizable, if die length of one side of opening is set up near the Ruhr limitation of an exposure machine on CAD. For example, said thin film for concavo-convex formation is formed using the mask drawn as a polygon which consists of the die length of 2 double less or equal of the resolution of the photolithography equipment used. Thus, since there is no acute angle part in the periphery edge of said thin film for concavo-convex formation when constituted, it can prevent that frequency dependent occurs in a dispersion property, and generating of the angle-of-visibility dependency of an image can also be prevented.
[0032] As for each the heights and the crevice which constitute said concavo-convex pattern, in this invention, it is desirable that the tilt angle to a substrate is [the flat-surface dimension for a flat part of 3 or less times] 10 micrometers or less. Thus, if constituted, it can prevent that frequency dependent occurs in a dispersion property, and generating of the angle-of-visibility dependency of an image can also be prevented.
[0033] As for said concavo-convex pattern, in this invention, it is desirable that the flat-surface distance between adjoining heights is the range from 5 times of the difference of elevation of said concavo-convex pattern to 20 times. Thus, if constituted, an angle-of-visibility dependency and level good about the both sides of the brightness of an image can be obtained. That is, if the flat-surface distance between adjoining heights exceeds 20 times of the difference of elevation of a concavo-convex pattern, an angle-of-visibility dependency will occur in an image instead of a specular reflection

component being too strong and a bright image being obtained in the direction of total reflection. On the other hand, an angle-of-visibility dependency will occur [the flat-surface distance between adjoining heights] in less than 5 times of the difference of elevation of a concavo-convex pattern. So, the brightness of an image is also securable while being able to suppress an angle-of-visibility dependency, if the flat-surface distance between adjoining heights is set as the range from 5 times of the difference of elevation of said concavo-convex pattern to 20 times.

[0034] In this invention, it is desirable that dispersion in the tilt angle of a side face is 5 or less times preferably 10 or less degrees in a field between each heights which constitute said concavo-convex pattern. If dispersion in a tilt angle is large, reflective brightness unevenness will occur, but if dispersion is suppressed even on such level, generating of brightness unevenness can be prevented. Such a configuration can be realized by performing dry etching (reactive ion etching), for example, RIE, or high density plasma etching, when forming the thin film for concavo-convex formation by the predetermined pattern.

[0035] As for each heights which constitute said concavo-convex pattern, in this invention, it is desirable that the inclination of a side face is unsymmetrical to the core of the heights concerned. Thus, when constituted, the reflected light will be tinctured with anisotropy and can raise the grace of a display using this anisotropy. For example, as for each heights which constitute said concavo-convex pattern, it is desirable that the one where the inclination of a side face is steeper considers as the configuration it has turned [configuration] to the direction of clear vision. Thus, the brightness of the whole image can be raised, maintaining the brightness by the side of the direction of clear vision, since the dispersion component to the direction of clear vision was strengthened when constituted. It is still more desirable when applying to the display using TN liquid crystal, and it is made in agreement with the direction of clear vision by the direction of orientation of the liquid crystal determined in the direction of rubbing.

[0036] When said thin film for concavo-convex formation consists of two or more electric conduction film at least in constituting such an unsymmetrical pattern, the convex pattern with which the electric conduction film of these plurality was left behind is considered as the configuration the core of a lap and whose core of each pattern has lapped mutually superficially at least partially, and do not correspond and which is an unsymmetrical pattern. Or when said thin film for concavo-convex formation consists of two or more insulator layers at least, the concave pattern by which opening was carried out to the insulator layer of these plurality is considered as the configuration the core of a lap and whose core of each pattern has lapped superficially at least partially and do not correspond and which is an unsymmetrical pattern. Or when consisting of at least one insulator layer and at least one electric conduction film, the core of the concave pattern by which opening was carried out to the convex pattern with which said electric conduction film was left behind, and said insulator layer considers said thin film for concavo-convex formation as the configuration distributed asymmetrically superficially.

[0037] As for said thin film for concavo-convex formation, in this invention, it is desirable to have the forward tapered shape configuration which comes to form the opening pattern by the side of the lower layer of the crevice where it always comes to form outside the remnants pattern by the side of the lower layer of the heights which constitute said concavo-convex pattern, and it constitutes said concavo-convex pattern from a remnants pattern by the side of the upper layer inside the opening pattern by the side of the upper layer. Thus, when said thin film for concavo-convex formation consists of two or more electric conduction film at least in constituting, the convex pattern with which the electric conduction film was left behind more in the upper layer is considered as the configuration always formed in the inside field of the formation field of the convex pattern with which the electric conduction film was left behind in the lower layer. Moreover, when said thin film for concavo-convex formation consists of two or more insulator layers at least, the concave pattern by which opening was carried out more to the insulator layer in the lower layer is considered as the configuration always formed in the inside field of the formation field of the convex pattern formed in the upper insulator layer.

Furthermore, when said thin film for concavo-convex formation consists of at least one insulator layer and at least one electric conduction film, the concave pattern by which opening was carried out to the convex pattern with which said electric conduction film was left behind, and said insulator layer is considered as the configuration which does not have the part which overlap mutually superficially.
[0038] That is, if it is a remnants pattern (convex pattern) when forming the thin film for concavo-convex formation in piles, the thin film for convex formation located in an upper layer side will consider more than two-layer as the configuration currently formed in the inside field of the formation field of the thin film for convex formation located in a lower layer side. Moreover, if it is an opening pattern (concave pattern) conversely, opening of the thin film for concave formation conversely located in an upper layer side will be considered as the configuration currently formed in the outside field of the opening field of the thin film for concave formation located in a lower layer side. Thus, if constituted, it can prevent that the thin film for concavo-convex formation located in an upper layer side will be in an overhang condition (inverse tapered shape), and since film peeling and a short circuit are mitigable, manufacture will become the yield is good and possible. Moreover, if it constitutes so that it may leave with opening (crevice) and the sections (heights) may not overlap superficially when forming combining a crevice and heights, the level difference formed with the thin film for concavo-convex formation located in a lower layer side will not be negated with the thin film for concavo-convex formation located in an upper layer side. Therefore, if such a configuration is adopted, when said thin film for concavo-convex formation will consist of two or more insulator layers or electric conduction film, even if the thickness of each insulator layer or the electric conduction film is 800nm or less, the concavo-convex pattern which has sufficient difference of elevation for the front face of the light reflex film can be formed.
[0039] In this invention, said electrooptic material is liquid crystal.
[0040] The electro-optic device which applied this invention can be used as a display of electronic equipment, such as a portable telephone and a mobile computer.
[0041]
[Embodiment of the Invention] The gestalt of operation of this invention is explained with reference to a drawing.
[0042] [The gestalt 1 of operation]
(Fundamental configuration of an electro-optic device) Drawing 1 is the top view which looked at the electro-optic device which applied this invention from the opposite substrate side with each component, and drawing 2 is the H-H' sectional view of drawing 1 . Drawing 3 is representative circuit schematics, such as various components in two or more pixels formed in the shape of a matrix in the image display field of an electro-optic device, and wiring. In addition, in order to make each class and each part material into the magnitude of extent which can be recognized on a drawing, scales are made to have differed for each class or every each part material in each drawing used for explanation of this gestalt.
[0043] boil the electro-optic device 100 of this gestalt sealant 52 in drawing 1 and drawing 2 -- the liquid crystal 50 as electrooptic material is pinched between the TFT array substrates 10 and the opposite substrates 20 which are and were stuck, and the circumference abandonment 53 which consists of a protection-from-light nature ingredient is formed in the inside field of the formation field of a sealant 52. The data-line drive circuit 101 and the mounting terminal 102 are formed in the field of the outside of a sealant 52 along with one side of the TFT array substrate 10, and the scanning-line drive circuit 104 is formed in it along with two sides which adjoin this one side. Two or more wiring 105 for connecting between the scanning-line drive circuits 104 established in the both sides of an image display field is formed in one side in which the TFT array substrate 10 remains, and a precharge circuit and an inspection circuit may be further prepared using the bottom of the circumference abandonment 53 etc. Moreover, in at least one place of the corner section of the opposite substrate 20, the vertical flow material 106 for taking an electric flow between the TFT array substrate 10 and the opposite substrate 20 is formed.
[0044] In addition, you may make it connect electrically and mechanically the TAB (tape automated **

bonding)·substrate with which LSI for a drive was mounted instead of forming the data-line drive circuit 101 and the scanning-line drive circuit 104 on the TFT array substrate 10 through the anisotropy electric conduction film to the terminal block formed in the periphery of the TFT array substrate 10. In addition, although a polarization film, a phase contrast film, a polarizing plate, etc. are arranged in an electro-optic device 100 at the predetermined sense according to the exception in in the mode of operation of **, and a normally white mode / normally black modes, such as the class of liquid crystal 50 to be used, i.e., TN (Twisted Nematic) mode, and STN (super TN) mode, illustration is omitted here. Moreover, in constituting an electro-optic device 100 as an object for color displays, in the opposite substrate 20, it forms the color filter of RGB in the field which counters each pixel electrode (it mentions later.) of the TFT array substrate 10 with the protective coat.

[0045] In the screen-display field of the electro-optic device 100 which has such structure As shown in drawing 3 , while two or more pixel 100a is constituted in the shape of a matrix, to each of such pixel 100a TFT30 for the pixel switching for driving pixel electrode 9a and this pixel electrode 9a is formed, and they are the pixel signals S1 and S2... Data-line 6a which supplies Sn is electrically connected to the source concerned of TFT30. Pixel signals S1 and S2 written in data-line 6a ... Sn may be supplied to line sequential and you may make it supply it to this order for every group to two or more data-line 6a which adjoin each other. Moreover, scanning-line 3a is electrically connected to the gate of TFT30, and they are the scan signals G1 and G2 in [in predetermined timing / scanning-line 3a] pulse... It is constituted so that Gm may be impressed to this order by line sequential. Pixel electrode 9a is the pixel signals S1 and S2 supplied from data-line 6a, when it connects with the drain of TFT30 electrically and only a fixed period makes TFT30 which is a switching element the ON state... Sn is written in each pixel to predetermined timing. thus, the pixel signals S1 and S2 of the predetermined level written in liquid crystal through pixel electrode 9a and ... fixed period maintenance of the Sn is carried out between the counterelectrodes 21 of the opposite substrate 20 shown in drawing 2 .

[0046] Here, when the orientation and order of molecular association change with the voltage levels impressed, liquid crystal 50 modulates light and enables a gradation display. The quantity of light to which incident light will pass the part of this liquid crystal 50 according to the impressed electrical potential difference if it is in no MARI White mode falls, and if it is in NOMA reeve rack mode, the quantity of light to which incident light passes the part of this liquid crystal 50 according to the impressed electrical potential difference increases. consequently -- as a whole -- the pixel signals S1 and S2 from an electro-optic device 100, and ... outgoing radiation of the light with the contrast according to Sn is carried out.

[0047] in addition, the held pixel signals S1 and S2 and ... in order to prevent Sn leaking, storage capacitance 60 may be added to the liquid crystal capacity and juxtaposition which are formed between pixel electrode 9a and a counterelectrode For example, as for the electrical potential difference of pixel electrode 9a, only long time amount is held with storage capacitance 60 more than the number twice of the scanning line rather than the time amount to which the source electrical potential difference was impressed. Thereby, it is improved and the maintenance property of a charge can realize the high electro-optic device 100 of a contrast ratio. In addition, as an approach of forming storage capacitance 60, as illustrated to drawing 3 , when taking the Cs on common structure formed between capacity line 3b which is wiring for forming storage capacitance 60, or also when taking the Cs on gate structure formed between scanning-line 3a of the preceding paragraph, you may be any.

[0048] (Configuration of a TFT array substrate) Drawing 4 is a top view of two or more pixel groups where the TFT array substrate used for the electro-optic device of this gestalt adjoins each other. Drawing 5 is a sectional view when cutting a part of pixel of an electro-optic device in the location equivalent to the A-A' line of drawing 4 . Drawing 6 is the sectional view expanding and showing signs that the concavo-convex pattern was formed in the front face of the light reflex film, in the field from which it separated from the formation field of TFT for pixel switching in the electro-optic device shown in drawing 5 .

[0049] In drawing 4 , on the TFT array substrate 10, pixel electrode 9a which consists of two or more transparent ITO (Indium Tin Oxide) film is formed in the shape of a matrix, and TFT30 for pixel switching has connected to each [these] pixel electrode 9a, respectively. Moreover, along the boundary of pixel electrode 9a in every direction, data-line 6a, scanning-line 3a, and capacity line 3b were formed, and TFT30 is connected to data-line 6a and scanning-line 3a. That is, data-line 6a was electrically connected to 1d of high concentration source fields of TFT30 through the contact hole, and pixel electrode 9a is electrically connected to high concentration drain field 1e of TFT3 through a contact hole. Moreover, scanning-line 3a is prolonged so that channel field 1a' of TFT30 may be countered. In addition, storage capacitance 60 uses as a bottom electrode what electric-conduction-ized 1f of installation parts of the semi-conductor film 1 for forming TFT30 for pixel switching, and has structure to which capacity line 3b lapped with the bottom [this] electrode 41 as an upper electrode.
[0050] thus, the cross section in the A-A' line of the constituted pixel field is shown in drawing 5 -- as -- the TFT array substrate 10 -- a base -- substrate protective coat 11a which thickness becomes from the silicon oxide (insulator layer) which is 300nm - 500nm is formed in the transparent front face of substrate 10', and semi-conductor film 1a of the shape of an island whose thickness is 50nm - 100nm is formed in the front face of this substrate protective coat 11a. Gate-dielectric-film 2a which thickness becomes from the silicon oxide which is about 50-150nm is formed in the front face of semi-conductor film 1a, and scanning-line 3a whose thickness is 300nm - 800nm passes as a gate electrode on the front face of this gate-dielectric-film 2a. The field which confronts each other through gate-dielectric-film 2a among semi-conductor film 1a to scanning-line 3a is channel field 1a'. To this channel field 1a', a source field equipped with low concentration source field 1b and 1d of high concentration source fields is formed in one side, and the drain field equipped with low concentration drain field 1c and high concentration drain field 1e is formed in the other side.
[0051] 1st interlayer insulation film 4a which thickness becomes from the silicon oxide which is 300nm - 800nm, and 2nd interlayer insulation film 5a (surface protective coat) which thickness becomes from the silicon nitride which is 100nm - 300nm are formed in the front-face side of TFT30 for pixel switching. Data-line 6a whose thickness is 300nm - 800nm was formed in the front face of 1st interlayer insulation film 4a, and this data-line 6a is electrically connected to it at 1d of high concentration source fields through the contact hole formed in 1st interlayer insulation film 4a. Drain electrode 6b by which coincidence formation was carried out with data-line 6a was formed in the front face of 1st interlayer insulation film 4a, and this drain electrode 6b is electrically connected to high concentration drain field 1e through the contact hole formed in 1st interlayer insulation film 4a.
[0052] The film which calcinated the polysilazane spreading film, or the transparent flattening film 7 which consists of acrylic resin is formed in the upper layer of 2nd interlayer insulation film 5a, and light reflex film 8a which consists of aluminum film etc. is formed in the front face of this flattening film 7.
[0053] Pixel electrode 9a which consists of ITO film is formed in the upper layer of light reflex film 8a. The laminating of the pixel electrode 9a is directly carried out to the front face of light reflex film 8a, and pixel electrode 9a and light reflex film 8a are connected electrically. Moreover, pixel electrode 9a is electrically connected to drain electrode 6b through the contact hole formed in the flattening film 7 and 2nd interlayer insulation film 5a.
[0054] The orientation film 12 which consists of polyimide film is formed in the front-face side of pixel electrode 9a. This orientation film 12 is film with which rubbing processing was performed to the polyimide film.
[0055] In addition, when capacity line 3b counters as an upper electrode through the insulator layer (dielectric film) by which coincidence formation was carried out with gate-dielectric-film 2a to 1f (bottom electrode) of installation parts from high concentration drain field 1e, storage capacitance 60 is constituted.
[0056] In addition, although TFT30 has LDD structure as mentioned above preferably, it may have the offset structure which does not drive impurity ion into the field equivalent to low concentration source

field 1b and low concentration drain field 1c. Moreover, TFT30 may be TFT of the self aryne mold which drove in impurity ion by high concentration by having used the gate electrode (a part of scanning-line 3a) as the mask, and formed the high-concentration source and a high-concentration drain field in self align.

[0057] Moreover, although considered as the single gate structure which has arranged one gate electrode (scanning-line 3a) of TFT30 between source-drain fields with this gestalt, two or more gate electrodes may be arranged among these. Under the present circumstances, to each gate electrode, the same signal is made to be impressed. Thus, if TFT30 is constituted above the dual gate (double-gate) or the triple gate, the leakage current in the joint of a channel and a source-drain field can be prevented, and the current at the time of OFF can be reduced. If at least one of these gate electrodes is made into LDD structure or offset structure, the OFF state current can be reduced further and the stable switching element can be obtained.

[0058] (Configuration of a concavo-convex pattern) As shown in drawing 5 and drawing 6 , concavo-convex pattern 8g equipped with heights 8b and crevice 8c is formed in the field (see drawing 4) from which it separated from the formation field of TFT30 among the front faces of light reflex film 8a at each pixel 100a of the TFT array substrate 10 constituted in this way.

[0059] In constituting such concavo-convex pattern 8g, with the TFT array substrate 10 of this gestalt, 11g of thin films for convex formation which consist of an insulator layer of substrate protective coat 11a and this layer is alternatively formed in the field equivalent to concavo-convex pattern 8g heights 8b by the predetermined pattern in the field from which it separated from the formation field of TFT30 in each pixel 100a in the 1st first. On the other hand, the insulator layer of substrate protective coat 11a and this layer is removed, and 11g of thin films for convex formation is not formed in the field equivalent to concavo-convex pattern 8g crevice 8c.

[0060] 2g of thin films for concavo-convex formation which consist of an insulator layer of gate-dielectric-film 2a and this layer was formed in the upper layer of 11g of thin films for convex formation, and 2g of this thin film for concavo-convex formation has lapped with the 2nd as completely as 11g of thin films for concavo-convex formation.

[0061] 3g of thin films for concavo-convex formation which become the upper layer of 2g of thin films for concavo-convex formation from the electric conduction film of gate electrode 3a and this layer is formed in the 3rd, and 3g of this thin film for concavo-convex formation is formed in that central field, without overflowing the formation field of 2g of thin films for concavo-convex formation. Here, 3g of thin films for concavo-convex formation is in the condition of having dissociated electrically with scanning-line 3a (gate electrode).

[0062] In the front face of 3g of thin films for concavo-convex formation, 4g of thin films for concavo-convex formation which consist of an insulator layer of 1st interlayer insulation film 4a and this layer is formed in the 4th, and 4g of this thin film for concavo-convex formation is formed in that central field, without overflowing the formation field of 2g of thin films for concavo-convex formation. However, 4g of thin films for concavo-convex formation was formed more widely than 3g of thin films for concavo-convex formation, and they have overflowed the formation field of 3g of this thin film for concavo-convex formation.

[0063] In the front face of 4g of thin films for concavo-convex formation, 6g of thin films for concavo-convex formation which consist of electric conduction film of data-line 6a and this layer is formed in the 5th, and 6g of this thin film for concavo-convex formation is formed in that central field, without overflowing the formation field of 4g of thin films for concavo-convex formation. Moreover, 6g of thin films for concavo-convex formation is formed in the central field, without overflowing the formation field of 3g of thin films for concavo-convex formation. Here, 6g of thin films for concavo-convex formation is in the condition of having dissociated electrically with data-line 6a (source electrode).

[0064] In the front face of 6g of thin films for concavo-convex formation, 5g of thin films for concavo-convex formation which consist of an insulator layer of 2nd interlayer insulation film 5a and this layer is

formed in the 6th, and 5g of this thin film for concavo-convex formation is formed in that central field, without overflowing the formation field of 4g of thin films for concavo-convex formation. However, 5g of thin films for concavo-convex formation was formed more widely than 6g of thin films for concavo-convex formation, and they have overflowed completely the formation field of 6g of this thin film for concavo-convex formation.

[0065] Thus, the film which calcinated the polysilazane spreading film, or the transparent flattening film 7 which consists of acrylic resin is formed in the front-face side of 6g of formed thin films for concavo-convex formation, and light reflex film 8a which consists of aluminum film etc. is formed in the front face of this flattening film 7. With this gestalt, with the level difference and irregularity which were formed of the thin films 11g, 2g, 3g, 4g, 6g, and 5g for concavo-convex formation, and those agenesis fields, for this reason, in the front face of light reflex film 8a The difference of elevation H (the total value and the equal value [Abbreviation] of each thin films [for concavo-convex formation / 11g, 2g, 3g, 4g, 6g, and 5g] thickness) 500nm or more, 800 morenm or more concavo-convex pattern 8g is formed, and it has become a gently-sloping configuration without an edge with the flattening film 7 this concavo-convex pattern 8g. Here, the thickness of the flattening film 7 is set as the range from [of the concavo-convex pattern 8g difference of elevation H] 1/2 to twice.

[0066] And any thin films 11g, 2g, 3g, 4g, 6g, and 5g for concavo-convex formation are formed with the flat-surface configuration in which a periphery edge does not have an acute angle (see drawing 4).

[0067] Moreover, in the field inboard of the TFT array substrate 10, it does not have the field where adjoining heights 8b is repeated with the flat-surface distance L of 20 micrometers or less concavo-convex pattern 8g, and the flat-surface distance L between adjoining heights 8a is in the range from 5 times of the difference of elevation H which is concavo-convex pattern 8g to 20 times concavo-convex pattern 8g.

[0068] Furthermore, the tilt angle alpha is formed so that, as for the thin films 11g, 2g, 3g, 4g, 6g, and 5g for concavo-convex formation and opening part by the side of a lower layer, the flat-surface dimension for a flat part of 3 or less times may be set to 10 micrometers or less, so that, as for each heights 8a and crevice 8b which constitute concavo-convex pattern 8g, the flat-surface dimension for a flat part of 3 or less times may be set to 10 micrometers or less by the tilt angle.

[0069] And the thin films 11g, 2g, 3g, 4g, 6g, and 5g for concavo-convex formation are formed so that dispersion in the tilt angle beta may become 10 or less degrees and 5 more times or less, so that dispersion in the tilt angle of a side face may become 10 or less degrees and 5 more times or less between each heights 8a which constitutes concavo-convex pattern 8g.

[0070] (Configuration of an opposite substrate) In drawing 5 and drawing 6 , with the opposite substrate 20, the light-shielding film 23 called a black matrix or a black stripe is formed in the border area of pixel electrode 9a currently formed in the TFT array substrate 10 in every direction, and the field which counters, and the counterelectrode 21 which consists of ITO film is formed in the upper layer side. Moreover, the orientation film 22 which consists of polyimide film is formed in the upper layer side of a counterelectrode 21, and this orientation film 22 is film with which rubbing processing was performed to the polyimide film.

[0071] (An operation of the electro-optic device of this gestalt, effectiveness) The electro-optic device 100 constituted in this way is liquid crystal equipment of a reflective mold, and light reflex film 8a which is from the aluminum film etc. on the lower layer side of pixel electrode 9a is formed. For this reason, since the light which carried out incidence from the opposite substrate 20 side is reflected by the TFT array substrate 10 side and outgoing radiation can be carried out from the opposite substrate 20 side, if liquid crystal 50 performs light modulation by each pixel 100a of every in the meantime, a desired image can be displayed using outdoor daylight by arranging suitable deflecting plate and phase contrast plate for the outside of the opposite substrate 20 (reflective mode).

[0072] Moreover, in an electro-optic device 100, if light reflex film 8a is formed so that field 8' shown according to a two-dot chain line by drawing 4 may be avoided, the liquid crystal equipment of

transflective and a half reflective mold can be constituted. In this case, back light equipment (not shown) is arranged to the TFT array substrate 10 side, and if incidence of the light by which outgoing radiation was carried out from this back light equipment is carried out from the TFT array substrate 10 side, this light can be penetrated to the opposite substrate 20 side through the field in which light reflex film 8a is not formed among the fields in which pixel electrode 9a is formed in each pixel 100a. For this reason, if liquid crystal 50 performs light modulation by each pixel 100a of every, a desired image can be displayed from back light equipment using the light by which outgoing radiation was carried out by arranging suitable deflecting plate and phase contrast plate for the outside of the opposite substrate 20 and the TFT array substrate 10 (transparent mode).
[0073] moreover, in the field which laps with light reflex film 8a superficially with this gestalt in by the side of the lower layer of light reflex film 8a The gate electrode (scanning-line 3a), source electrode (data-line 6a) which constitute TFT30, And form alternatively the thin film of at least one layer in each insulator layer, and this layer by the predetermined pattern as thin films 11g, 2g, 3g, 4g, 6g, and 5g for concavo-convex formation, and the level difference and irregularity resulting from the existence of this thin film for concavo-convex formation are used. Concavo-convex pattern 8g is formed in the front face of light reflex film 8a. Therefore, since light diffuses the light which carried out incidence from the opposite substrate 20 side when displaying an image in reflective mode in case it is reflected by light reflex film 8a, it is hard to generate an angle-of-visibility dependency in an image. Here gate electrode (scanning-line 3a), source electrode (data-line 6a), and 1st interlayer insulation film 4a and 2nd interlayer insulation film 5a In order to carry out patterning of the thin film formed in the whole front face of substrate 10' using a photolithography technique, The process for forming gate electrode (scanning-line 3a), source electrode (data-line 6a), and 1st interlayer insulation film 4a and 2nd interlayer insulation film 5a can be used as it is, and the thin films 3g, 4g, 6g, and 5g for concavo-convex formation of this layer can be respectively formed by the pattern of arbitration with them. Therefore, it can form about these thin films 3g, 4g, 6g, and 5g for concavo-convex formation, without adding not only a photograph RISOSOGURAFI process but any process.
[0074] Moreover, 11g of thin films for concavo-convex formation which consist of an insulator layer of them and this layer, since it is not concerned with whether concavo-convex pattern 8g is formed in light reflex film 8a but membranes are formed, substrate insulator layer 11a and gate-dielectric-film 2a do not need to add a membrane formation process, either, although it leaves 2g alternatively.
[0075] Furthermore, since it is also easy to avoid the field which forms TFT30 and to form concavo-convex pattern 8g (thin films 11g, 2g, 3g, 4g, 6g, and 5g for concavo-convex formation) according to this gestalt, there is no trouble in forming TFT30 by micro processing.
[0076] Moreover, rather than the lower layer side of light reflex film 8a, and 6g of thin films for concavo-convex formation, the flattening film 7 is formed using the ingredient which has a fluidity, the level difference and irregularity which originate in thin films [for concavo-convex formation / 11g 2g, 3g, 4g, 6g, and 5g] existence with this flattening film 7 are negated moderately, and concavo-convex pattern 8g of a gently-sloping configuration without an edge is formed in an upper layer side. Therefore, generating of the angle-of-visibility dependency resulting from an edge can be prevented. And if the thickness of the flattening film 7 exceeds the twice of the difference of elevation H which is concavo-convex pattern 8g Irregularity will be eliminated with the flattening film 7 and a specular reflection component is too strong. Although the angle-of-visibility dependency which cannot eliminate an edge certainly but originates in an edge with the flattening film 7 will occur in under double [of the difference of elevation H whose thickness of the flattening film 7 is concavo-convex pattern 8g / 1 / 2 double] while an angle-of-visibility dependency occurs in an image instead of a bright image being obtained With this gestalt, since it is set as the range from [of the difference of elevation / in / for the thickness of the flattening film 7 / concavo-convex pattern 8g / H] 1/2 to twice, while being able to suppress an angle-of-visibility dependency, the brightness of an image is also securable.
[0077] Since the thin film for concavo-convex formation is formed more than two-layer, even when

forming concavo-convex pattern 8g which has sufficient difference of elevation H for the front face of light reflex film 8a, it is not necessary to form the thick thin film unsuitable for TFT30 further again.
[0078] And among the two-layer thin films 3g and 6g for concavo-convex formation which consist of electric conduction film of each of scanning-line 3a and data-line 6a, and this layer, 6g of thin films for concavo-convex formation located in an upper layer side is formed in the inside field of the formation field of 3g of thin films for concavo-convex formation located in a lower layer side, and they have not overflowed. Moreover, among the thin films 11g, 2g, 4g, and 5g for concavo-convex formation of four layers respectively set to substrate protective coat 11a, gate-dielectric-film 2a, 1st interlayer insulation film 4a, and 2nd interlayer insulation film 5a from the insulator layer of this layer, the thin film for concavo-convex formation located in an upper layer side is formed in the inside field of the formation field of the thin film for concavo-convex formation located in a lower layer side, and has not overflowed. For this reason, each thin film for concavo-convex formation which constitutes concavo-convex pattern 8g has forward tapered shape structure, and will not be in an overhang condition (inverse tapered shape), but there is no fear of film peeling and the film remainder resulting from an overhang occurring. The two-layer thin films 3g and 6g for concavo-convex formation which consist of electric conduction film left behind to each and this layer of scanning-line 3a and data-line 6a further again have not lapped with opening and the flat-surface target which did etching removal to the insulator layer which constitutes substrate protective coat 11a, gate-dielectric-film 2a, 1st interlayer insulation film 4a, and 2nd interlayer insulation film 5a. For this reason, since the level difference formed with the thin film for concavo-convex formation located in a lower layer side and irregularity are not negated with the thin film for concavo-convex formation located in an upper layer side, concavo-convex pattern 8g which has sufficient difference of elevation H for the front face of light reflex film 8a can be formed.
[0079] Moreover, 3g of thin films for concavo-convex formation which consist of electric conduction film of scanning-line 3a and this layer is made scanning-line 3a and the configuration separated electrically. And since it has considered as data-line 6a and the configuration which dissociated electrically, 6g of thin films for concavo-convex formation which consist of electric conduction film of data-line 6a and this layer Through the thin films 3g and 6g for concavo-convex formation, it will not be in other components and short circuit conditions, or capacity (3g and 6g) will not be added for scanning-line 3a and data-line 6a to the capacity of 3a and 6a.
[0080] Moreover, with this gestalt, the aluminum film, the tantalum film, the molybdenum film, or the alloy film that uses either of these metals as a principal component is used as electric conduction film which constitutes scanning-line 3a and data-line 6a, and these electric conduction film has a comparatively quick membrane formation rate, and since it can carry out patterning to a good configuration by dry etching, it can form 6g suitably efficiently 3g of thin films for concavo-convex formation.
[0081] Moreover, with this gestalt, silicon oxide is used as an insulator layer which constitutes substrate protective coat 11a and 1st interlayer insulation film 4a, and this silicon oxide has a comparatively quick membrane formation rate, and since it can carry out patterning to a good configuration by dry etching, it can form 4g suitably efficiently 11g of thin films for concavo-convex formation.
[0082] Moreover, in this gestalt, concavo-convex pattern 8g, since adjoining heights 8a does not have the field repeated with the flat-surface distance L of 20 micrometers or less, generating of the interference color can be prevented. That is, in concavo-convex pattern 8g, if the field where the adjoining heights 20 are repeated with the flat-surface distance L of 20 micrometers or less exists, the interference color will occur in relation with the wavelength of light, but if there is such no repeat field, generating of the interference color can be prevented.
[0083] Moreover, with this gestalt, since 500nm or more of concavo-convex pattern 8g differences of elevation H is further set to 800nm or more, the situation where the concavo-convex pattern 8g difference of elevation H is too small, frequency dependent occurs and an image colors in a visible region in a dispersion property is avoidable.
[0084] Moreover, since the periphery edge is formed with the flat-surface configuration which does not

have an acute angle, it can prevent that frequency dependent occurs in a dispersion property, and any thin films 11g, 2g, 3g, 4g, 6g, and 5g for concavo-convex formation can also prevent generating of the angle-of-visibility dependency of an image.
[0085] Furthermore, as for the thin films 11g, 2g, 3g, 4g, 6g, and 5g for concavo-convex formation and opening part by the side of a lower layer, the tilt angle alpha is [the flat-surface dimension for a flat part of 3 or less times of heights 8a and crevice 8b from which it constitutes concavo-convex pattern 8g since the tilt angle alpha is formed so that the flat-surface dimension for a flat part of 3 or less times may be set to 10 micrometers or less] 10 micrometers or less. For this reason, it can prevent that frequency dependent occurs in a dispersion property, and generating of the angle-of-visibility dependency of an image can also be prevented.
[0086] Furthermore, concavo-convex pattern 8g, since the flat-surface distance L between adjoining heights 8a is the range from 5 times of the difference of elevation H which is concavo-convex pattern 8g to 20 times, an angle-of-visibility dependency and level good about the both sides of the brightness of an image can be obtained. That is, if the flat-surface distance L between adjoining heights 8a exceeds 20 times of the difference of elevation H which is concavo-convex pattern 8g, an angle-of-visibility dependency will occur in an image instead of a specular reflection component being too strong and a bright image being obtained. On the other hand, an angle-of-visibility dependency will occur in less than 5 times of the difference of elevation H whose flat-surface distance L between adjoining heights 8a is concavo-convex pattern 8g. However, with this gestalt, since the flat-surface distance L between adjoining heights 8a is set as the range from 5 times of the concavo-convex pattern 8g difference of elevation H to 20 times, while being able to suppress an angle-of-visibility dependency, the brightness of an image is also securable.
[0087] Moreover, since the thin films 11g, 2g, 3g, 4g, 6g, and 5g for concavo-convex formation are formed with this gestalt so that dispersion in the tilt angle beta may become 10 or less degrees and 5 more times or less, dispersion in the tilt angle beta of a side face is also 10 or less degrees and 5 more times or less in a field between each heights 8a which constitutes concavo-convex pattern 8g. For this reason, generating of the brightness unevenness resulting from dispersion in the tilt angle beta can be prevented.
[0088] [the manufacture approach of TFT] -- how to manufacture TFT30 of such a configuration is explained with reference to drawing 7 thru/or drawing 10 . Drawing 7 , drawing 8 , drawing 9 , and drawing 10 are the process sectional views showing the manufacture approach of the TFT array substrate 11 of this gestalt, and are equivalent to the cross section in the A-A' line of drawing 4 also in which drawing.
[0089] First, as shown in drawing 7 (A), after preparing substrate 10', such as glass [which was defecated by ultrasonic cleaning etc.], the insulator layer 11 which consists of silicon oxide for forming substrate protective coat 11a all over substrate 10' under the temperature conditions whose substrate temperature is 150 degrees C - 450 degrees C is formed in the thickness of 300nm - 500nm by the plasma-CVD method. As material gas at this time, the mixed gas of a mono silane and laughter gas, TEOS and oxygen or a disilane, and ammonia can be used, for example.
[0090] Next, substrate temperature forms in the thickness of 50nm - 100nm the semi-conductor film 1 which consists of amorphous silicon film by the plasma-CVD method all over substrate 10' under the temperature conditions which are 150 degrees C - 450 degrees C. As material gas at this time, a disilane and a mono silane can be used, for example. Next, a laser beam is irradiated to the semi-conductor film 1, and laser annealing is given. Consequently, the amorphous semi-conductor film 1 is fused once, and is crystallized through a cooling solidification process. In this case, the irradiation time of the laser beam to each field is very a short time, and to the whole substrate, since it is local, an exposure field is not heated for the whole substrate by coincidence at an elevated temperature, either. So, even if it uses a glass substrate etc. as substrate 10', deformation, a crack, etc. by heat do not arise.
[0091] Next, by using a photolithography technique for the front face of the semi-conductor film 1,

forming the resist mask 551, and etching the semi-conductor film 1 through this resist mask 551, as shown in drawing 7 (B), island-like semi-conductor film 1a (active layer) is formed.
[0092] Next, the insulator layers 2, such as silicon oxide for forming gate-dielectric-film 2a etc. in the front face of semi-conductor film 1a with a CVD method etc., are formed in the thickness of 50nm - 150nm all over substrate 10' under temperature conditions 350 degrees C or less. The mixed gas of TEOS and oxygen gas can be used for the material gas at this time. The insulator layer 2 formed here may be replaced with silicon oxide, and may be a silicon nitride.
[0093] Next, although illustration is omitted, impurity ion is driven into 1f of installation parts of semi-conductor film 1a through a predetermined resist mask, and the bottom electrode for constituting storage capacitance 60 between capacity line 3b is formed.
[0094] Next, by a spatter etc., as shown in drawing 7 (C), after forming in the thickness of 300nm - 800nm the aluminum film for forming scanning-line 3a etc., the tantalum film, the molybdenum film, or the electric conduction film 3 that consists of alloy film which uses either of these metals as a principal component all over substrate 10', the resist mask 552 is formed using a photolithography technique.
[0095] Next, as dry etching of the electric conduction film 3 is carried out and it is shown in drawing 7 (D) through the resist mask 552, scanning-line 3a (gate electrode) and capacity line 3b are formed. Under the present circumstances, it leaves 3g of thin films for concavo-convex formation which consist of electric conduction film of scanning-line 3a and this layer to the field from which it separated from the formation field of TFT30. Here, 3g of thin films for concavo-convex formation is formed in the condition of having dissociated from scanning-line 3a electrically.
[0096] Next, they are about 0.1x1013-/cm2 - about 10x1013-/cm2, using scanning-line 3a and a gate electrode as a mask at the pixel TFT section and N channel TFT section (not shown) side of a drive circuit. Impurity ion (phosphorus ion) low-concentration with a dose is driven in, and low concentration source field 1b and low concentration drain field 1c are formed in self align to scanning-line 3a. Here, since it is located just under scanning-line 3a, the part into which impurity ion was not introduced becomes channel field 1a' with semi-conductor film 1a.
[0097] Next, as shown in drawing 7 (E), in the pixel TFT section, the resist mask 553 with wide width of face is formed from scanning-line 3a (gate electrode), and they are about 0.1x1015-/cm2 - about 10x1015-/cm2 about high-concentration impurity ion (phosphorus ion). It is devoted with a dose and high concentration source field 1b and 1d of drain fields are formed.
[0098] It may replace with these impurity installation processes, the high-concentration impurity (phosphorus ion) in the condition of having formed the resist mask with width of face wider than a gate electrode, without driving in a low-concentration impurity may be driven in, and the source field and drain field of offset structure may be formed. Moreover, scanning-line 3a may be used as a mask, a high-concentration impurity may be driven in, and, of course, the source field and drain field of self aryne structure may be formed.
[0099] In addition, although illustration is omitted, and the N channel TFT section of the circumference drive circuit section is formed according to such a process, in this case, the P channel TFT section is covered with the mask. Moreover, they are about 0.1x1015-/cm2 - about 10x1015-/cm2, carrying out covering protection of the pixel section and the N channel TFT section by the resist, and using a gate electrode as a mask, in case the P channel TFT section of a circumference drive circuit is formed. By driving in boron ion with a dose, the source drain field of a P channel is formed in self align. Under the present circumstances, a gate electrode is used as a mask like the time of formation of the N channel TFT section. About 0.1x1013-/cm2 - about 10x1013-/cm2 An impurity (boron ion) low-concentration with a dose is introduced. A mask with width of face wider than a gate electrode after forming a low concentration field in the polish recon film is formed, and they are about 0.1x1015-/cm2 - about 10x1015-/cm2 about a high-concentration impurity (boron ion). It is devoted with a dose. The source field and drain field of LDD structure (the Rheydt Lee doped drain structure) may be formed. Moreover, the high-concentration impurity (phosphorus ion) in the condition of having formed the mask with width

of face wider than a gate electrode may be driven in without driving in a low-concentration impurity, and the source field and drain field of offset structure may be formed. According to these ion implantation processes, CMOS-ization is attained and the built-in of it into the same substrate of a circumference drive circuit is attained.

[0100] Next, as shown in drawing 7 (F), after forming the resist mask 554 using a photolithography technique, dry etching of the insulator layers 2 and 11 is carried out through the resist mask 554, and as shown in drawing 8 (A), it leaves the thin films 2g and 11g for concavo-convex formation respectively set to gate-dielectric-film 2a and substrate protective coat 11a from the insulator layer of this layer to the field which laps with 3g of thin films for concavo-convex formation in a lower layer side.

[0101] Next, as shown in drawing 8 (B), the insulator layers 4, such as silicon oxide for forming 1st interlayer insulation film 4a, are formed in the front-face side of scanning-line 3a with a CVD method etc. at the thickness of 300nm - 800nm. The mixed gas of TEOS and oxygen gas can be used for the material gas at this time.

[0102] Next, the resist mask 555 is formed using a photolithography technique.

[0103] Next, dry etching is performed to an insulator layer 4 through the resist mask 555, and as shown in drawing 8 (C), in 1st interlayer insulation film 4a, a contact hole is formed in the part corresponding to a source field and a drain field, respectively. Under the present circumstances, it leaves 4g of thin films for concavo-convex formation which consist of an insulator layer of 1st interlayer insulation film 4a and this layer to the field which laps with 3g of thin films for concavo-convex formation.

[0104] Next, as shown in drawing 8 (D), after forming in the thickness of 300nm - 800nm the electric conduction film 6 which consists of the aluminum film for constituting data-line 6a (source electrode) etc., the tantalum film, molybdenum film, or alloy film that uses either of these metals as a principal component by a spatter etc., the resist mask 556 is formed in the front-face side of 1st interlayer insulation film 4a using a photolithography technique.

[0105] Next, dry etching is performed on the electric conduction film 6 through the resist mask 556, and as shown in drawing 8 (E), data-line 6a and drain electrode 6b are formed. Under the present circumstances, it leaves 6g of thin films for concavo-convex formation which consist of electric conduction film of data-line 6a and this layer to the field which laps with 4g of thin films for concavo-convex formation. 6g of this thin film for concavo-convex formation is formed in the condition of having dissociated from data-line 6a electrically.

[0106] Next, as shown in drawing 9 (A), the resist mask 557 for forming a contact hole etc. in the front-face side of data-line 6a and drain electrode 6b with a CVD method etc., at 2nd interlayer insulation film 5a using a photolithography technique, after forming the insulator layers 5, such as a silicon nitride for forming 2nd interlayer insulation film 5a, in 100nm - 300nm thickness is formed.

[0107] Next, dry etching is performed to an insulator layer 5 through the resist mask 557, and as shown in drawing 9 (B), a contact hole is formed in the part corresponding to the drain electrode 14 among 2nd interlayer insulation film 5a. Under the present circumstances, it leaves 5g of thin films for concavo-convex formation which consist of an insulator layer of 2nd interlayer insulation film 5a and this layer to the field which laps with 6g of thin films for concavo-convex formation.

[0108] Next, as shown in drawing 9 (C), after applying the constituent containing perhydro polysilazane or this, it calcinates, or acrylic resin is applied and the flattening film 7 is formed in the front-face side of 2nd interlayer insulation film 5a and 5g of thin films for concavo-convex formation.

[0109] Here, since the flattening film 7 is formed from what applied the ingredient which has a fluidity, the level difference and irregularity resulting from thin films [for concavo-convex formation / 11g 2g, 3g, 4g, 6g, and 5g] existence are moderately negated in the front face of the flattening film 7, and the concavo-convex pattern of a gently-sloping configuration without an edge is formed in it. However, since an edge is certainly eliminable if the flattening film 7 is too thin while irregularity will be eliminated with the flattening film 7, if the flattening film 7 is too thick, about the thickness of the flattening film 7, it is set as the range from the 1/2 twice as many abbreviation for thin films [for concavo-convex

formation / 11g 2g, 3g, 4g, 6g, and 5g] sum total thickness as this to a twice as many abbreviation as this.
[0110] In addition, perhydro polysilazane is a kind of inorganic polysilazane and is a spreading mold coating ingredient converted into silicon oxide by calcinating in atmospheric air. For example, the polysilazane by TONEN CORP. is inorganic polymer which makes -(SiH2 NH)- a unit, and is meltable to organic solvents, such as a xylene. Therefore, if it calcinates in atmospheric air at the temperature of 450 degrees C after applying with a spin coat method (for example, for 2000rpm and 20 seconds) by using the organic solvent solution (for example, 20% xylene solution) of this inorganic polymer as coating liquid, it can react with moisture and oxygen and the silicon oxide which formed membranes with the CVD method, and the precise amorphous silicon oxide more than equivalent can be obtained.
[0111] Next, after forming the resist mask 558 for forming a contact hole in the flattening film 7 using a photolithography technique, it etches into the flattening film 7 through the resist mask 558, and a contact hole is formed as shown in drawing 9 (D). In addition, after exposing and developing a direct ingredient in the photolithography when a photosensitive ingredient is used for the flattening film 7, after applying and prebaking an ingredient, the same contact hole can be obtained by carrying out postbake.
[0112] Next, by a spatter etc., as shown in drawing 10 (A), after forming the metal membrane 8 equipped with the reflexibility of the aluminum film etc. in the front face of the flattening film 7, the resist mask 559 is formed using a photolithography technique.
[0113] Next, it etches into a metal membrane 8 through the resist mask 559, and as shown in drawing 10 (B), it leaves light reflex film 8a to a predetermined field. Thus, 800 morenm [500nm or more and] or more concavo-convex pattern 8g is formed in the front face of formed light reflex film 8a of the level difference and irregularity which were formed of the thin films 11g, 2g, 3g, 4g, 6g, and 5g for concavo-convex formation, and those agenesis fields, and it has become a gently-sloping configuration without an edge with the flattening film 7 this concavo-convex pattern 8g.
[0114] Next, as shown in drawing 10 (C), after thickness forms the ITO film 9 which is 40nm - 200nm by a spatter etc., the resist mask 560 is formed in the front-face side of light reflex film 8a using a photolithography technique.
[0115] Next, it etches into the ITO film 9 through the resist mask 560, and as shown in drawing 10 (D), pixel electrode 9a electrically connected to drain electrode 6b is formed.
[0116] As shown in after an appropriate time at drawing 5 and drawing 6 , the polyimide film (orientation film 12) is formed in the front-face side of pixel electrode 9a. It heats and hardens, after carrying out flexographic printing of the polyimide varnish made to dissolve 5 - 10% of the weight of polyimide, and a polyamide acid in solvents, such as butyl cellosolve and n-methyl pyrrolidone, to it (baking). And the substrate in which the polyimide film was formed is ground in the fixed direction with the puff cloth which consists of rayon system fiber, and a polyimide molecule is made to arrange in the fixed direction near the front face. Consequently, a liquid crystal molecule arranges in the fixed direction by the interaction of the liquid crystal molecule and polyimide molecule filled with later.
[0117] Thus, the TFT array substrate 10 is manufactured. In addition, at the time of the design of an exposure mask, although it is desirable that the periphery edge is formed with the flat-surface configuration which does not have an acute angle as for the thin films 11g, 2g, 3g, 4g, 6g, and 5g for concavo-convex formation, such a configuration is realizable, if die length of one side of opening is set as the following near the Ruhr limitation of an exposure machine on CAD. Moreover, since it is desirable that dispersion in the tilt angle of a side face is 5 or less times preferably 10 or less degrees between each heights 8b which constitutes concavo-convex pattern 8g, if RIE or high density plasma etching is performed among various dry etching when forming the thin film for concavo-convex formation, dispersion in the tilt angle of the side face between each heights 8b can be suppressed small.
[0118] [Gestalt 2 of operation] drawing 11 (A) and (B) are the process sectional views showing the characteristic process in the manufacture approach of the TFT array substrate of the electro-optic device concerning the gestalt 2 of operation of this invention. Drawing 12 is the sectional view

expanding and showing signs that the concavo-convex pattern was formed in the front face of the light reflex film, in the field from which it separated from the formation field of TFT for pixel switching in the electro-optic device concerning the gestalt 2 of operation of this invention. In addition, those explanation is omitted, while giving the same sign to a common part and illustrating to drawing 11 and drawing 12 , since the fundamental configuration of the gestalt of this operation and any [which is explained below] gestalt of operation is the same as that of the gestalt 1 of operation.
[0119] Although the insulator layer 4 was etched and it left 4g of thin films for concavo-convex formation with the gestalt 1 of operation as shown in drawing 8 (B) and (C) after etching insulator layers 2 and 11 and leaving the thin films 2g and 11g for concavo-convex formation, as shown in drawing 7 (F) and drawing 8 (A) Until it forms an insulator layer 4 with this gestalt, as shown in drawing 11 (A) In case insulator layers 2 and 11 are not etched but an insulator layer 4 is formed through the resist mask 555, as shown in drawing 11 (B), insulator layers 2 and 11 are etched into coincidence, and the thin films 11g, 2g, and 4g for concavo-convex formation are formed in coincidence. For this reason, according to this gestalt, as compared with the gestalt 1 of operation, a photolithography process can be reduced once.
[0120] Also when such a manufacture approach is adopted, as shown in drawing 1212 , concavo-convex pattern 8g can be formed in the front face of light reflex film 8a with the level difference and irregularity which were formed of the thin films 11g, 2g, 3g, 4g, 6g, and 5g for concavo-convex formation, and those agenesis fields.
[0121] [Gestalt 3 of operation] drawing 13 (A) and (B) are the process sectional views showing the characteristic process in the manufacture approach of the TFT array substrate of the electro-optic device concerning the gestalt 3 of operation of this invention. Drawing 14 is the sectional view expanding and showing signs that the concavo-convex pattern was formed in the front face of the light reflex film, in the field from which it separated from the formation field of TFT for pixel switching in the electro-optic device concerning the gestalt 3 of operation of this invention.
[0122] Although insulator layers 2 and 11 were etched into coincidence and the thin films 11g, 2g, and 4g for concavo-convex formation were formed in coincidence with the gestalt 2 of operation as explained with reference to drawing 11 (A) and (B) With this gestalt, as shown in drawing 13 (A), it leaves semi-conductor film 1a″ of semi-conductor film 1a' of TFT30, and this layer to the field equivalent to concavo-convex pattern 8g [of a light reflex film 8a front face] crevice 8c. In this condition As shown in drawing 13 (B), dry etching of the insulator layer 4 is carried out, and 4g of thin films for concavo-convex formation is formed.
[0123] Thus, since the insulator layer 11 from which semi-conductor film 1a″ functions as an etching stopper, and constitutes substrate protective coat 11a will not be etched as shown in drawing 14 if constituted, it can leave the substrate protective coat 11 all over the TFT array substrate 10.
[0124] Moreover, with this gestalt, concavo-convex pattern 8g can be formed in the front face of light reflex film 8a with the level difference and irregularity which were formed of the thin films 3g, 4g, 6g, and 5g for concavo-convex formation, and those agenesis fields.
[0125] [Gestalt 4 of operation] drawing 15 is the sectional view expanding and showing signs that the concavo-convex pattern was formed in the front face of the light reflex film, in the field from which it separated from the formation field of TFT for pixel switching in the electro-optic device concerning the gestalt 4 of operation of this invention.
[0126] Since the thin films 11g, 2g, 3g, 4g, 6g, and 5g for concavo-convex formation were formed with the gestalt 1 of operation, respectively so that the core might be in agreement as shown in drawing 6 , In concavo-convex pattern 8g formed in the front face of light reflex film 8a, although the inclination of the side face of each heights 8a was symmetrical to the core of heights 8a and the reflected light was isotropic With this gestalt, as shown in drawing 15 R> 5, the core is made in agreement about the thin films 11g, 2g, 3g, 4g, and 5g for concavo-convex formation, and the center position is shifted in the direction of clear vision about 6g of thin films for concavo-convex formation from the thin films [for concavo-convex formation / 11g, 2g, 3g, 4g, and 5g] center position. For this reason, the core of the

concave-pattern by which opening was carried out to the convex pattern with which the electric conduction film was left behind, and the insulator layer is distributed asymmetrically superficially.
[0127] Thus, when constituted, in concavo-convex pattern 8g formed in the front face of light reflex film 8a, the inclination of the side face of each heights 8a becomes unsymmetrical to the core of heights 8a, and the reflected light will be tinctured with anisotropy. Therefore, the grace of a display can be raised using this anisotropy. That is, in the example shown in drawing 15 , the brightness of the whole image can be raised in each heights 8a which constitutes concavo-convex pattern 8g, maintaining the brightness by the side of the direction of clear vision, since the one where the inclination of a side face is steeper was suitable in the direction of clear vision, and the dispersion component to the direction of clear vision was strengthened.
[0128] [Gestalt 5 of operation] drawing 16 is the sectional view expanding and showing signs that the concavo-convex pattern was formed in the front face of the light reflex film, in the field from which it separated from the formation field of TFT for pixel switching in the electro-optic device concerning the gestalt 5 of operation of this invention.
[0129] In carrying out un-isotropic ** of the reflected light from light reflex film 8a, as shown in drawing 16 , a mutual core is made in agreement about the thin films 11g, 2g, 4g, and 5g for concavo-convex formation, and the center position may be shifted in the direction of clear vision produced from a thin films [for concavo-convex formation / 11g, 2g, 4g, and 5g] center position by rubbing processing about the thin films 3g and 6g for concavo-convex formation. Thus, a configuration distributes superficially asymmetrically the core of the concave pattern by which opening was carried out to the convex pattern with which the electric conduction film was left behind, and the insulator layer.
[0130] Thus, also when constituted, in concavo-convex pattern 8g formed in the front face of light reflex film 8a, the inclination of the side face of each heights 8a becomes unsymmetrical to the core of heights 8a, and the reflected light will be tinctured with anisotropy. Therefore, the brightness of the whole image can be raised, maintaining the brightness by the side of the direction of clear vision like this gestalt, in each heights 8a which constitutes concavo-convex pattern 8g, since the dispersion component to the direction of clear vision was strengthened when making the one where the inclination of a side face is steeper turn to in the direction of clear vision.
[0131] [Gestalt 6 of operation] drawing 17 is the sectional view of the electro-optic device concerning the gestalt 6 of operation of this invention.
[0132] With the gestalten 1-5 of operation, although TFT30 for pixel switching formed in each pixel 100a was the poly-Si TFT of a forward stagger mold or a KOPURANA mold, as shown in drawing 17 , TFT, an amorphous silicon TFT, etc. of a reverse stagger mold may use TFT of other formats for pixel switching.
[0133] thus, also when constituted, as shown in drawing 17 , in the TFT array substrate 10, in the field from which it separated from the formation field of TFT30 of a reverse stagger mold 3g of thin films for crevice formation which consist of electric conduction film of scanning-line 3a (gate electrode) and this layer, If 6g of thin films for crevice formation which consist of 2g of thin films for crevice formation which consist of an insulator layer of gate-dielectric-film 2a and this layer, and electric conduction film of data-line 6a and this layer is alternatively formed in a predetermined pattern Concavo-convex pattern 8g can be formed in the front face of light reflex film 8a with the level difference and irregularity which were produced by those formation fields and agenesis fields.
[0134] Although the electro-optic device 100 of [application on the electronic equipment of an electro-optic device] thus the constituted reflective mold, or a transflective and a half reflective mold can be used as a display of various kinds of electronic equipment, it explains the example with reference to drawing 18 , drawing 19 , and drawing 20 .
[0135] 18 is the block diagram showing the circuitry of electronic equipment using the electro-optic device concerning this invention as an indicating equipment.
[0136] In drawing 18 , electronic equipment has the source 70 of a display information output, the display information processing circuit 71, a power circuit 72, a timing generator 73, and liquid crystal

equipment 74. Moreover, liquid crystal equipment 74 has the liquid crystal display panel 75 and the drive circuit 76. As liquid crystal equipment 74, the electro-optic device 100 mentioned above can be used.

[0137] The source 70 of a display information output is equipped with the tuning circuit which carries out the alignment output of storage units, such as memory, such as ROM (Read Only Memory) and RAM (Random Access Memory), and various disks, and the digital picture signal, and supplies the display information of the picture signal of a predetermined format etc. to the display information processing circuit 71 based on various kinds of clock signals generated by the timing generator 73.

[0138] The display information processing circuit 71 is equipped with the various circuits of common knowledge, such as a serial-parallel conversion circuit, and magnification and an inverter circuit, a rotation circuit, a gamma correction circuit, a clamping circuit, performs processing of display information in which it inputted, and supplies the picture signal to the drive circuit 76 with a clock signal CLK. A power circuit 72 supplies a predetermined electrical potential difference to each component.

[0139] Drawing 19 shows the personal computer of the mobile mold which is 1 operation gestalt of the electronic equipment concerning this invention. The personal computer 80 shown here has the body section 82 equipped with the keyboard 81, and the liquid crystal display unit 83. The liquid crystal display unit 83 is constituted including the electro-optic device 100 mentioned above.

[0140] Drawing 20 shows the portable telephone which are other operation gestalten of the electronic equipment concerning this invention. The portable telephone 90 shown here has two or more manual operation buttons 91 and the display which consists of an electro-optic device 100 mentioned above.

[0141]

[Effect of the Invention] As above, by this invention, it forms in the field which laps with the light reflex film and a flat-surface target in by the side of the lower layer of the light reflex film alternatively by the predetermined pattern by using the thin film of each wiring, and an at least one layer in an insulator layer and this layer as the thin film for concavo-convex formation, and a concavo-convex pattern is formed in the front face of the light reflex film using the level difference and irregularity resulting from the existence of this thin film formation for concavo-convex formation. Here, neither wiring nor an insulator layer is concerned with whether irregularity is given to the light reflex film, but it is formed, and they are surely formed by carrying out patterning using a photolithography technique, after forming a predetermined thin film in the whole front face of a substrate. For this reason, the process which forms wiring and an insulator layer can be used as it is, and the thin film for concavo-convex formation of they and this layer can be alternatively formed by the predetermined pattern. Therefore, the light reflex film to which a membrane formation process is added and which was equipped with the optical diffusion function, without adding can be formed. Moreover, since it is also easy to avoid the field which forms an active component and to form the thin film for concavo-convex formation on a substrate, there is no trouble in performing micro processing for forming an active component.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is a top view when seeing an electro-optic device from an opposite substrate side.
[Drawing 2] It is a sectional view in the H-H' line of drawing 1 .
[Drawing 3] In an electro-optic device, they are representative circuit schematics formed in two or more pixels arranged in the shape of a matrix, such as various components and wiring.
[Drawing 4] In the electro-optic device concerning the gestalt 1 of operation of this invention, it is the top view showing the configuration of each pixel formed in the TFT array substrate.
[Drawing 5] It is a sectional view when cutting in the location which is equivalent to the A-A' line of drawing 4 in the electro-optic device concerning the gestalt 1 of operation of this invention.
[Drawing 6] In the electro-optic device shown in drawing 5 , it is the sectional view expanding and showing signs that the concavo-convex pattern was formed in the front face of the light reflex film, in the field from which it separated from the formation field of TFT for pixel switching.
[Drawing 7] (A) - (F) is the process sectional view showing the manufacture approach of the TFT array substrate of the electro-optic device concerning the gestalt 1 of operation of this invention.
[Drawing 8] (A) - (E) is the process sectional view of each process performed following the process shown in drawing 7 in the manufacture approach of the TFT array substrate of the electro-optic device concerning the gestalt 1 of operation of this invention.
[Drawing 9] (A) - (D) is the process sectional view of each process performed following the process shown in drawing 8 in the manufacture approach of the TFT array substrate of the electro-optic device concerning the gestalt 1 of operation of this invention.
[Drawing 10] (A) - (D) is the process sectional view of each process performed following the process shown in drawing 9 in the manufacture approach of the TFT array substrate of the electro-optic device concerning the gestalt 1 of operation of this invention.
[Drawing 11] (A) and (B) are the process sectional views showing the characteristic process in the manufacture approach of the TFT array substrate of the electro-optic device concerning the gestalt 2 of operation of this invention.
[Drawing 12] In the electro-optic device concerning the gestalt 2 of operation of this invention, it is the sectional view expanding and showing signs that the concavo-convex pattern was formed in the front face of the light reflex film, in the field from which it separated from the formation field of TFT for pixel switching.
[Drawing 13] (A) and (B) are the process sectional views showing the characteristic process in the manufacture approach of the TFT array substrate of the electro-optic device concerning the gestalt 3 of operation of this invention.
[Drawing 14] In the electro-optic device concerning the gestalt 3 of operation of this invention, it is the sectional view expanding and showing signs that the concavo-convex pattern was formed in the front face of the light reflex film, in the field from which it separated from the formation field of TFT for pixel switching.
[Drawing 15] In the electro-optic device concerning the gestalt 4 of operation of this invention, it is the sectional view expanding and showing signs that the concavo-convex pattern was formed in the front face of the light reflex film, in the field from which it separated from the formation field of TFT for pixel switching.
[Drawing 16] In the electro-optic device concerning the gestalt 5 of operation of this invention, it is the sectional view expanding and showing signs that the concavo-convex pattern was formed in the front face of the light reflex film, in the field from which it separated from the formation field of TFT for pixel switching.
[Drawing 17] It is the sectional view of the electro-optic device concerning the gestalt 6 of operation of

this invention.
[Drawing 18] It is the block diagram showing the circuitry of electronic equipment using the electro-optic device concerning this invention as an indicating equipment.
[Drawing 19] It is the explanatory view showing the personal computer of the mobile mold as 1 operation gestalt of electronic equipment using the electro-optic device concerning this invention.
[Drawing 20] It is the explanatory view of the portable telephone as 1 operation gestalt of electronic equipment using the electro-optic device concerning this invention.
[Drawing 21] It is the sectional view of the conventional electro-optic device.
[Description of Notations]
1a Semi-conductor film
1a' Field for channel formation
1b Low concentration source field
1c Low concentration drain field
1d High concentration source field
1e High concentration drain field
2a Gate dielectric film
2g Gate dielectric film and thin film for concavo-convex formation of this layer
3a Scanning line
3b Capacity line
3g Thin film for concavo-convex formation of the scanning line and this layer
4a The 1st interlayer insulation film
4g The 1st interlayer insulation film and thin film for concavo-convex formation of this layer
5a The 2nd interlayer insulation film
5g The 2nd interlayer insulation film and thin film for concavo-convex formation of this layer
6a Data line
6g Thin film for concavo-convex formation of the data line and this layer
7 Flattening Film
8a Light reflex film
8b Heights of a concavo-convex pattern
8c The crevice of a concavo-convex pattern
8g Concavo-convex pattern of a light reflex film front face
9a Pixel electrode
10 TFT Array Substrate
11a Substrate protective coat
11g A substrate protective coat and thin film for concavo-convex formation of this layer
20 Opposite Substrate
21 Counterelectrode
23 Light-shielding Film
30 TFT for Pixel Switching
50 Liquid Crystal
53 Circumference Abandonment
60 Storage Capacitance
100 Electro-optic Device
100a Pixel

[Translation done.]